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Physical Rehabilitation and Critical Illness

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Abstract

Survivors of critical illness suffer a range of physical, psychological and social problems known together as the post-ICU syndrome. Physical weakness is common, long lasting, and interferes with quality of life for many ICU survivors. Physical weakness observed close to the time of ICU discharge is likely be caused by the disordered physiology and immobility associated with critical illness. These factors may be less important in the long term, where pre-existing frailty may be more important. A large number of trials have tested physical interventions (exercise, passive and active mobilization, and neuromuscular electrical stimulation) delivered during and after critical illness. At this time, the evidence suggests that early mobilization can improve important short-term outcomes (such as length of stay, duration of mechanical ventilation, functional independence, and mobility), and may increase days out of hospital alive at 180 days. Effects on other long-term outcomes (such as quality of life) have not been shown. No physical interventions delivered after ICU discharge have demonstrated effectiveness. This article describes the physical problems experienced by ICU survivors, and provides an up to date review of critical care physical intervention trials.

Keywords

Critical Care; Muscular Diseases; Rehabilitation; Muscle Weakness

Learning objectives

After reading this article, you should be able to:

- Describe the physical problems faced by intensive care unit survivors
- Outline the causes of intensive care unit acquired weakness
- Describe key evidence relating to the prevention and treatment of intensive care unit acquired weakness in critically ill adults

Royal College of Anaesthetists CPD Matrix

3C00 Adult ICM

Introduction

Patients that survive critical illness suffer a range of adverse issues including physical, psychological, and social challenges that define the post-intensive care syndrome (PICS). These issues are prevalent and impact on physical function, employment, and readmission to hospital soon after discharge. ICU survivors have substantial rehabilitation needs. The historical lack of integrated rehabilitation pathways (like those available to patients suffering from strokes, heart attacks, or head injuries), is being addressed in some centres and our appreciation of the complex and specific needs of this patient group is improving.

Rehabilitation can be defined as the process of returning to a normal (or as close to normal) life after illness. This topic review focuses on the prevention and treatment of intensive care unit acquired weakness, although readers should be aware that common psychological complications (such as depression and post-traumatic stress disorder), may prevent patients participating in physical rehabilitation, will likely compound ongoing disability, and should also be considered as part of a holistic rehabilitation package.

Prevention of physical problems seems to be better than cure: interventions delivered alongside other ICU treatment have shown benefit, whereas treatments delivered after ICU have not. There is general acceptance that early mobilisation makes a difference to the physical outcomes of ICU patients. Although there is an increasing interest in neuromuscular electrical stimulation (NMES), in-bed cycling, and nutrition-based interventions, these treatments still lack a firm evidence base.

Intensive Care Unit Acquired Weakness (ICUAW)

An acquired muscle weakness (intensive care unit acquired weakness [ICUAW]) is the major cause of early post-ICU disability and results in delayed weaning from mechanical ventilation and increased mortality. Pre-critical illness health and function are important determinants of long-term physical function. Most patients with ICUAW have muscular atrophy, termed critical illness myopathy (CIM), whereas a smaller number experience axonal damage, termed critical illness neuropathy (CIPN). In addition to structural damage, reversible impairments in ion channel transport, and mitochondrial function, contribute to weakness in the short term.

Interventions

In this article we discuss several approaches to preventing or treating ICUAW. Early mobilisation is physical activity performed within the first few days of admission to ICU and can include both passive and active movement (e.g. ambulation, resistance exercises, and range of motion exercise). NMES is the percutaneous application of electrical impulses to muscles to cause them to contract. In-bed cycling uses a specialist cycle ergometer which attaches to the patient's bed, allowing gentle

leg exercise that can be active or passive. Nutritional support covers a range of oral and parental supplements, specialist input from dietitians, and other interventions designed to optimise the patient's nutrient intake.

- Summary of evidence from ICU rehabilitation trials

Important trials evaluating physical interventions (including exercise, mobilisation, and cycle ergometry) are detailed in table 1.

Preventing ICUAW: ICU Interventions

In 2009, Schweichert and colleagues published a trial of 104 ventilated patients in ICU testing the effect of an early mobilization intervention (<72 hours of mechanical ventilation)¹. They found a greater proportion of patients in the intervention group returned to independent function, that they had less [delirium](#), and a shorter period of [mechanical ventilation](#). The results of subsequent trials have not consistently shown benefit. A 2017 systematic review (14 trials, n=1753) explored the effects of active mobilisation interventions delivered during ICU and found no effect on mortality, and variable effects on quality of life, duration of ICU, mechanical ventilation, or hospitalisation². Meta-analysis revealed greater muscle strength at ICU discharge, walking without assistance at hospital discharge, and days alive out of hospital by day 180 in those who received active rehabilitation². Sub-group analysis revealed that 'higher dose' rehab for >30 mins per day was associated with significantly better quality of life².

Ding and colleagues conducted a meta-analysis to determine the optimum time for initiation of mobilisation in mechanically ventilated patients³. In the 13 studies included, timing of mobilisation ranged from within 24 –96 hours of starting mechanical ventilation³. The meta-analysis showed that early mobilisation commenced between 48-and 2 hours of mechanical ventilation may be optimal to improve ICUAW and reduce the duration of mechanical ventilation, but did not significantly impact length of ICU stay³. Future studies are needed to confirm the optimal timing of intervention, and to determine the impact on important patient-centred outcomes³. In 2016, a systematic review (12 trials, n=449) evaluated the use of NMES in critically ill patients⁴. The review found that NMES has potential to preserve muscle mass and joint range of motion, reduce activity limitations, and improve ventilation outcomes, but highlighted that the current evidence is significantly limited due to small sample sizes, high or unclear risk of bias and significant heterogeneity in the populations included, characteristics and site of the NMES applied outcome measures⁴. No study included patient follow-up beyond the end of NMES⁴. Several studies suggested that NMES may be more effective in treating rather than preventing ICUAW but future high-quality studies are required to determine long-term impacts, and to reach consensus on the optimal application and outcome measures.

Several small studies have investigated the use of cycle ergometry in ICU, and have suggested it may be effective in reducing ICUAW, however the observed effects are inconsistent and only in-hospital outcomes have been explored.

Treating ICUAW: Post-ICU interventions

Taito and colleagues systematically recently reviewed the evidence on rehabilitation interventions following ICU (10 trials, n= 1110), including interventions starting from on the acute ward, to starting after hospital discharge⁵. In the studies included, the duration of intervention ranged from 6 to 12 weeks, with frequency ranging from 3 times weekly to once daily⁵. A high or unclear risk of bias was acknowledged in all studies due to insufficient description of the intervention and control protocols, so the quality of this evidence is mixed⁵. This review showed that enhanced post-ICU rehabilitation did not improve quality of life or reduce mortality at 6 or 12 months⁵. The effect on body function and muscle strength was not clear⁵. Confounding may be harder to control for in post-ICU samples, as more resilient or highly-motivated individuals may have been working independently on exercise rehabilitation and derived benefit from this, or been more likely to adhere to self-directed interventions. It is likely that ICU survivors would benefit from ongoing rehabilitation in the post-ICU period, but the evidence suggests that perhaps benefit can only be attained if interventions are started earlier in the critical illness trajectory.

A recent review of nutrition and ICU rehabilitation included 2 studies which trialled oral nutritional supplementation (initiated post-ICU) combined with enhanced physical rehabilitation, and found conflicting results⁶. Future studies are indicated to determine the optimum nutrition required in both the ICU and post-ICU period, and how this can best support physical interventions.

Conclusions and recommendations

There is convincing evidence that physical rehabilitation should be started soon after patients are admitted to the intensive care unit, and that these measures are likely to improve short term outcomes. Neuromuscular electrostimulation and nutritional supplementation may be important. At this time, there is little evidence to suggest that these measure improve long-term physical function, and interventions initiated after ICU, have so far not shown to be of benefit.

References

- 1 Schweickert WD, Pohlman MC, Pohlman AS, *et al.* Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial. *Lancet (London, England)*2009; **373**: 1874–82.
- 2 Tipping CJ, Harrold M, Holland A, Romero L, Nisbet T, Hodgson CL. The effects of active mobilisation and rehabilitation in ICU on mortality and function: a systematic review. *Intensive Care Med* 2017; **43**: 171–83.
- 3 Ding N, Zhang Z, Zhang C, *et al.* What is the optimum time for initiation of early mobilization in mechanically ventilated patients? A network meta-analysis. *PLoS One* 2019; **14**: e0223151.

- 4 Burke D, Gorman E, Stokes D, Lennon O. An evaluation of neuromuscular electrical stimulation in critical care using the ICF framework: a systematic review and meta-analysis. *Clin Respir J* 2016; **10**: 407–20.
- 5 Taito S, Yamauchi K, Tsujimoto Y, Banno M, Tsujimoto H, Kataoka Y. Does enhanced physical rehabilitation following intensive care unit discharge improve outcomes in patients who received mechanical ventilation? A systematic review and meta-analysis. *BMJ Open* 2019; **9**: e026075.
- 6 Kou K, Momosaki R, Miyazaki S, Wakabayashi H, Shamoto H. Impact of Nutrition Therapy and Rehabilitation on Acute and Critical Illness: A Systematic Review. *J UOEH* 2019; **41**: 303–15.
- 7 Schaller SJ, Anstey M, Blobner M, *et al.* Early, goal-directed mobilisation in the surgical intensive care unit: a randomised controlled trial. *Lancet (London, England)* 2016; **388**: 1377–88.
- 8 Walsh TS, Salisbury LG, Merriweather JL, *et al.* Increased Hospital-Based Physical Rehabilitation and Information Provision After Intensive Care Unit Discharge: The RECOVER Randomized Clinical Trial. *JAMA Intern Med* 2015; **175**: 901–10.
- 9 McDowell K, O'Neill B, Blackwood B, *et al.* Effectiveness of an exercise programme on physical function in patients discharged from hospital following critical illness: a randomised controlled trial (the REVIVE trial). *Thorax* 2017; **72**: 594–5.
- 10 Fossat G, Baudin F, Courtes L, *et al.* Effect of In-Bed Leg Cycling and Electrical Stimulation of the Quadriceps on Global Muscle Strength in Critically Ill Adults: A Randomized Clinical Trial. *JAMA* 2018; **320**: 368–78.

Page Break

Tables

	n	Patients	Intervention	Control	Findings
Physical interventions delivered during intensive care					
Schweickert 2009 ¹	104	ICU patients ventilated <72h	Progressive exercise and mobilization	Routine care	Higher proportion returned to independence by hospital discharge. No effect on physical outcomes.
Schaller 2016 ⁷	200	ICU patients ventilated <48h	Early, goal-directed mobilization	Routine care	Functional mobility at hospital discharge was higher. ICU length of stay was shorter. More adverse events were reported.

Physical interventions delivered after intensive care

Walsh 2015 ⁸	240	ICU patients ventilated >48h ready for ICU discharge	Hospital based complex rehabilitation involving generic rehabilitation assistant 6 week individualized community based physical intervention	Routine care	No effect on physical function, health-related quality of life or symptoms at 3 months
McDowell 2017 ⁹	60	ICU patients ventilated >96h	6 week individualized community based physical intervention	Routine care	No effect on self-reported physical function

Other intervention trials

Fossat 2018 ¹⁰	312		Electrical stimulation of the quadriceps muscle and early in-bed leg cycling	Standardized early rehabilitation programme	Global muscle strength at ICU discharge was not affected.
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